

Potential and Exploitation Status of Hampala Fish (*Hampala macrolepidota*) in Lake Singkarak Based on Size Structure and Exploitation Rate

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ABSTRACT: Hampala fish (*Hampala macrolepidota*) is one of the economically important species in Lake Singkarak, West Sumatra, targeted by local fishers using hook and line, gill nets, and destructive methods including explosives. This study aimed to analyze the potential and exploitation status of Hampala fish based on size structure and population dynamics parameters. Field sampling was conducted from November 2015 to October 2016 using gill nets and hook and line as the primary fishing gear. A total of 951 specimens were measured. Results showed that total length frequency distributions ranged from 54–166 mm (119.01 ± 24.50 mm) for juveniles, 175–405 mm (284.76 ± 37.54 mm) for males, and 167–603 mm (380.38 ± 80.93 mm) for females. Length-weight relationships indicated negative allometric growth in juveniles ($b = 2.815$) and males ($b = 2.740$), and positive allometric growth in females ($b = 3.105$). Total mortality rate (Z) was estimated at 0.835 per year, with an exploitation rate (E) of 0.258. The E value, well below the threshold of 0.5, indicates that Hampala fish in Lake Singkarak remains in a sustainable condition; however, preventive management is imperative given the species' vulnerability to intensified exploitation.

KEYWORDS: *Hampala macrolepidota*, Lake Singkarak, Size Distribution, Length-Weight Relationship, Exploitation Rate, Population Dynamics.

I. INTRODUCTION

Lake Singkarak is one of the largest natural lakes in West Sumatra, harboring high aquatic biodiversity, including the Hampala fish or Barau (*Hampala macrolepidota* Kuhl & Van Hasselt, 1823) [16]. This species belongs to the family Cyprinidae and is widely distributed throughout the Sundaland and Indochina regions [15, 16, 20]. Morphologically, Hampala fish exhibits a torpedo-shaped body, a subterminal mouth with thick lips, and a characteristic dark blotch between the dorsal and pelvic fins that fades progressively with growth [15, 26].

Hampala fish holds significant economic value in local markets and represents the primary target species for commercial and artisanal fishers in Lake Singkarak [28, 31]. Harvesting is carried out through various methods, including hook and line, gill nets, and even explosives, the latter being non-selective and highly destructive [6, 35]. Inappropriate fishing practices may lead to population decline, while artificial propagation for stock enhancement has yet to be comprehensively implemented [1, 33].

Previous studies have investigated various biological aspects of Hampala fish across different water bodies [7, 14]. Tessier et al. [32] reported that in Nam Theun 2 Reservoir, Laos, Hampala fish exhibited relatively slow growth ($K = 0.24$ per year) with a maximum age of approximately 9 years, and an exploitation rate of 0.87, indicating an overfishing condition. In contrast, Herlan and Wulandari [10] recorded an exploitation rate of 0.16 per year for Sebarau fish (*H. macrolepidota*) in Lake Ranau, South Sumatra, which remained well below the sustainable threshold. These divergent findings underscore the site-specific nature of Hampala fish exploitation status and the necessity for localized assessments [11, 30].

Population dynamics parameters, particularly mortality rates and exploitation indices, are fundamental tools in fisheries management [4, 27]. The exploitation rate (E), calculated as the ratio of fishing mortality (F) to total mortality (Z), serves as a key indicator for evaluating whether a stock is underfished ($E < 0.5$), optimally exploited ($E = 0.5$), or overfished ($E > 0.5$) [9, 24]. Accurate estimation of these parameters is therefore essential for formulating evidence-based management recommendations [5, 14].

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This study aimed to: (1) determine the size distribution and growth pattern of *H. macrolepidota* in Lake Singkarak; (2) estimate population dynamics parameters, including growth parameters (L_{∞} , K), total mortality rate (Z), and exploitation rate (E); and (3) assess the exploitation status of Hampala fish in Lake Singkarak as a basis for management recommendations.

II. METHOD

A. Study Location and Sampling Period

This study was conducted in Lake Singkarak, West Sumatra Province, Indonesia. Sampling was carried out monthly from November 2015 to October 2016, covering a complete annual cycle to capture seasonal variation in fish size structure and abundance [29, 37].

B. Data Collection

Fish specimens were obtained from the catches of local fishers using gill nets and hook and line as the primary fishing gear [13]. Each captured fish was measured for total length (TL) using a ruler with 1 mm precision and weighed using a digital scale with 0.1 g precision [2]. Fish were subsequently classified by sex and gonadal maturation stage following Nikolsky [21] and Bagenal [3].

C. Data Analysis

- **Size Frequency Distribution:** Total length data were grouped into 50 mm class intervals and tabulated as size frequency distributions to characterize the population structure of Hampala fish [25, 35].
- **Length-Weight Relationship:** The relationship between total length and body weight was analyzed using the allometric equation $W = aL^b$, where W is body weight (g), L is total length (mm), a is the intercept, and b is the allometric coefficient [7, 17]. The growth pattern was determined based on the value of b : isometric ($b = 3$), negative allometric ($b < 3$), or positive allometric ($b > 3$) [24].
- **Growth Parameters:** L_{∞} =65.0 cm, K =0.68 per year [8, 30].
- **Total Mortality Rate (Z):** Z =0.835 per year [4, 23].
- **Natural Mortality Rate (M):** M =0.620 per year [14, 30].
- **Fishing Mortality (F) and Exploitation Rate (E):** F =0.215 per year, E =0.258 [5, 9, 27].

III. RESULT AND DISCUSSION

A. Size Frequency Distribution

Based on measurements of 951 Hampala fish specimens collected during the study period, the total length frequency distribution is presented in Table 1.

Table 1. Total Length Frequency Distribution of *H. macrolepidota* in Lake Singkarak (Nov 2015 – Oct 2016)

No.	Length Class Interval (mm)	Number of Individuals	Frequency (%)
1	54 – 103	150	15.77
2	104 – 153	368	38.70
3	154 – 203	126	13.25
4	204 – 253	43	4.52
5	254 – 303	127	13.35
6	304 – 353	82	8.62
7	354 – 403	21	2.21
8	404 – 453	15	1.58
9	454 – 503	10	1.05
10	504 – 553	7	0.74
11	554 – 603	2	0.21
Total	—	951	100.00

The size distribution of Hampala fish exhibited a broad range (54–603 mm), with a clear dominance of small- to medium-sized individuals [35, 36]. The 104–153 mm size class was the most abundant, accounting for 38.70% of total catches, followed by the 54–103 mm class (15.77%). The prevalence of small-bodied fish suggests that the harvesting area in Lake Singkarak also functions as a nursery ground for juvenile Hampala [22, 28].

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The marked size dimorphism between sexes was evident, with females attaining considerably larger sizes (167–581 mm) than males (175–405 mm), indicating distinct sexual dimorphism typical of many cyprinid fishes [7, 21]. Monthly catch fluctuations were also pronounced (Table 2), with peak abundances recorded in March 2016 (174 individuals) and August 2016 (241 individuals), suggesting temporal associations with spawning migrations or seasonal aggregation behavior [19].

Table 2. Monthly Distribution of Hampala Fish Catches in Lake Singkarak (2015–2016)

Month	Number of Individuals
Nov-15	42
Dec-15	27
Jan-16	37
Feb-16	72
Mar-16	174
Apr-16	68
May-16	64
Jun-16	23
Jul-16	34
Aug-16	241
Sep-16	92
Oct-16	77
Total	951

B. Length-Weight Relationship and Growth Pattern

Length-weight analysis demonstrated strong correlations between total length and body weight across all groups [7, 17]. The resulting corrected allometric equations are:

- Juveniles: $W = 0.975 L^{2.815}$ ($r^2 = 0.907$)
- Males: $W = 0.992 L^{2.740}$ ($r^2 = 0.836$)
- Females: $W = 0.985 L^{3.105}$ ($r^2 = 0.801$)

The growth pattern was negative allometric for juveniles ($b = 2.815 < 3$) and males ($b = 2.740 < 3$), indicating a slender body form [3, 14]. Conversely, females exhibited positive allometric growth ($b = 3.105 > 3$), resulting in a heavier and more robust body form [7] due to higher reproductive investments [21, 36].

C. Growth Parameters, Mortality Rates, and Exploitation Rate

- **Growth Parameters:** $L_{\infty} = 59.5$ cm, $K = 0.75$ per year [8, 30].
- **Total Mortality Rate (Z):** $Z = 0.835$ per year [4, 23].
- **Natural Mortality Rate (M):** $M = 0.75$ per year [14, 30].
- **Fishing Mortality (F) and Exploitation Rate (E):** $F = 0.085$ per year, $E = 0.102$ [5, 9, 27].

D. Exploitation Status

The calculated exploitation rate ($E = 0.102$) is substantially below the optimal sustainability threshold of $E = 0.5$, confirming an underfished and healthy condition [9, 11], contrasting with overfished results in other regions like Nam Theun 2 Reservoir, Laos [32]. However, critical threats such as high juvenile catch proportions and destructive fishing methods require proactive management attention [6, 14, 33, 35].

IV. CONCLUSIONS

Hampala fish (*H. macrolepidota*) in Lake Singkarak exhibited a broad size range (54–603 mm), with the 104–153 mm size class dominating (38.70%). Length-weight analyses showed negative allometric growth in juveniles and males, and positive allometric growth in females. Total mortality rate (Z) was 0.835 per year, with an exploitation rate (E) of 0.102, confirming a sustainable stock status ($E < 0.5$). Preventive management and habitat protection are strongly recommended.

Potential and Exploitation Status of Hampala Fish (*Hampala macrolepidota*) in Lake Singkarak Based on Size Structure and Exploitation Rate

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Potential and Exploitation Status of Hampala Fish (*Hampala macrolepidota*) in Lake Singkarak Based on Size Structure and Exploitation Rate

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